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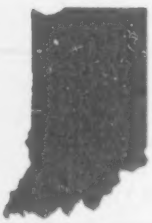

Indiana Business Review

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William Ritteman — **Indiana Employment Growth, 1960-1981: An Examination of the Industrial Mix Hypothesis**

Thomas W. Hertel and Lance McKinzie — **Input-Output Analysis for the Indiana Economy**

Indiana Employment Growth, 1960-1981: An Examination of the Industrial Mix Hypothesis

In this issue . . .

How does the economy of Indiana work? What is it doing now? How did it get here? Where is it going? Those are the questions asked by Indiana economists and citizens alike and the questions most frequently discussed in these pages.

For this issue we have two structured analyses of the state's economic functioning. The performance of Indiana relative to the nation is the focus of the article by Bill Ritteman of the Indiana State Department of Commerce. He tests the assumptions of the industrial mix hypothesis against available data on recessionary and expansionary periods in Indiana and the U.S.

Thomas W. Hertel and Lance McKinzie of Purdue University offer an input-output analysis of the state's economy, arguing that adding value by increasing the share of processing done in the state could increase employment and income. By studying the interrelationships between sectors of the State's economy, they develop an impact analysis which can be used by policy makers.

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William M. Ritteman, *Senior Economic Analyst, Division of Economic Analysis, Indiana Department of Commerce.* *The author would like to express his appreciation for the valuable data processing services provided by Zoe Teague, Consultant for Interactive Data Corporation, Chase Econometrics.*

Recent recessionary problems in the Midwest have once again focused attention on the sensitivity of Indiana and neighboring states to swings in the national business cycle and on the fact that Indiana experiences greater swings in employment and income through these cycles than does the nation as a whole. The predominant explanation for this sensitivity—industrial mix—is largely taken for granted. Though Indiana's heavy employment concentration in sensitive industries such as auto parts and steel production presents a plausible explanation for the State's cyclical sensitivity, available research based on recent data is lacking.

It is reasonable to assume that industrial mix is a factor in determining the magnitude of Indiana business cycles, but it would be useful to understand the degree of its influence. In this article, we quantify the role that industrial mix played in determining Indiana's cyclical employment fluctuations since 1960. In doing so, we will attempt to test what may be termed the "industrial mix hypothesis," an explanation for the procyclical tendency of Indiana employment levels that occurs in both recessions and expansions.

Indiana employment usually increases or decreases with the national economy, though at a more rapid rate. According to the industrial mix hypothesis, this tendency results from a disproportionately high concentration of employment in cyclically sensitive industries that are most heavily affected by sharp changes in consumer spending during upturns and downturns. Our study is preceded by a description of the business cycles which have occurred since 1960.

Efforts to identify and describe state cyclical behavior have established Indiana's cyclical sensitivity. An earlier study completed by G.H. Borts in 1960 attempted to test the industrial mix hypothesis by imposing hypothetical employment weights on state data. Using this method to equate state and national industry composition, Borts concluded that the severity of state cyclicality was not solely determined by industrial composition. Further, Borts' method of measuring cyclical amplitude revealed that Indiana was the fifth most sensitive state among 33 studied during the period from 1914-1951.[1]

There are some studies, such as the above, which attempt to explore underlying causes, but research of a descriptive nature is more readily available. H. Friedenberg and R. Bretzfelder, for example, measured the "cyclical swing" in state nonfarm payrolls by calculating the difference between mean quarterly percent changes during expansions and recessionary periods. These authors discovered that Indiana sustained greater swings than all other states except Michigan during the 1948-1973 period of study. Further, during these postwar years, Indiana's cyclical swing stood at 13.6% in contrast with a U.S. swing of 7.8%.[2]

Indiana Employment Cycles, 1960-1981

To simplify our selection of peaks and troughs for defining contractions and expansions in each cycle, we have elected to use dates set forth by the National Bureau of Economic Research (NBER). Although the timing and duration of Indiana expansions and contractions usually do not exactly correspond to those experienced by the U.S., this approach eliminates the subjectivity sometimes associated with

1. G.H. Borts, "Regional Cycles of Manufacturing Employment in the United States, 1914-1953," *Journal of the American Statistical Association*, 1969: 151-211.

2. H. Friedenberg, and R. Bretzfelder, "Sensitivity of Regional and State Nonfarm Wages and Salaries to National Business Cycles, 1948-79," U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, May 1980: 15-27.

selection of dates at the state level. The dates of NBER designated contractions and expansions since 1960 are listed below.

Table 1

Dates of Recessions and Expansions Designated by the National Bureau of Economic Research

Type of Period	*Dates of Employment Period*
Contraction	April 1960-February 1961
Expansion	February 1961-December 1969
Contraction	December 1969-November 1970
Expansion	November 1970-November 1973
Contraction	November 1973-March 1975
Expansion	March 1975-January 1980
Contraction	January 1980-July 1980
Expansion	July 1980-July 1981

During the period from April 1960 through July 1981, Indiana experienced large employment swings. Table 2 provides historical estimates of Indiana employment with percent changes under the "Actual Indiana Employment" column. Indiana and U.S. employment declines during recessionary periods averaged roughly 6% and 2.3%, respectively, from 1960 to 1981. In each of the four recessionary periods, the Indiana employment decline was several percentage points greater than the decline sustained at the U.S. level. During the four periods of decline, Indiana employment fell by 4.6%, 5.6%, 7.4%, and roughly 6.0%, respectively. National employment declined by only 2.6%, 2.0%, 3.1%, and 1.6% during the corresponding periods. Viewing each of the Indiana downturns in succession, a mild pattern of increasing declines is evident from the first through the third recessionary period where employment dropped 7.4%. In the final period of decline, Indiana employment fell by a slightly smaller percentage. National employment evidenced no clear pattern of increasing or decreasing employment declines during these periods; the first and third employment declines were higher than those experienced in the second and fourth periods of employment loss.

To compare the severity of Indiana's employment decline during recessions with the decline at the national level during the corresponding period, an index has been developed. (See the "Actual Indiana Employment Sensitivity" column found in Table 3.) The employment gain or loss in each period, for both Indiana and the U.S., is expressed as a percentage of the initial month's employment level in the given period. Indiana's percent change in employment during each period was divided by the corresponding U.S. percent change to obtain an index that expresses the relationship of Indiana's and the nation's employment fluctuations. An index number around 1, for example, would indicate that Indiana and the nation experienced roughly the same rate of employment change during a given period. Index numbers above 1 indicate periods where Indiana's rate of employment change exceeded that experienced at the national level. An index number below 1 indicates a period where Indiana's rate of employment change was below the nation's.

Table 2

Actual and Simulated Total Indiana Employment and Total U.S. Employment at Inflection Points With Percent Changes[1]

Period	*Actual Indiana Employment*	*Percent Change*	*Adjusted Indiana Employment*[2]	*Percent Change*	*Actual U.S. Employment*	*Percent Change*
4/60–2/61	1,198.388	–4.63	1,219.472	–2.95	43,583	–2.63
2/61–12/69	1,596.110	33.19	1,598.836	33.42	57,365	31.62
12/69–11/70	1,506.465	–5.62	1,538.561	–3.61	56,231	–1.98
11/70–11/73	1,741.521	15.60	1,727.582	14.68	62,599	11.32
11/73–3/75	1,612.282	–7.42	1,659.531	–4.71	60,681	–3.06
3/75–1/80	1,850.149	14.75	1,883.117	16.80	73,516	21.15
1/80–7/80	1,738.224	–6.05	1,756.392	–5.07	72,304	–1.65
7/80–7/81	1,787.823	2.85	1,775.159	2.12	74,325	2.79

1. Monthly estimates in thousands at end of contraction and expansionary periods, April 1960-July 1981. Percent changes are from initial to terminal employment levels expressed as a percentage of initial employment level in each period.
2. Indiana employment adjusted for the U.S. industrial mix in each period.

Table 3

Indiana Relative to U.S., Computed for Actual and Adjusted Indiana Employment Values[1]

Period	*Actual Indiana Employment Sensitivity vs. U.S. Employment Sensitivity*	*Adjusted Indiana Employment Sensitivity vs. U.S. Employment Sensitivity*
4/60-2/61	1.76	1.12
2/61-12/69	1.05	1.06
12/69-11/70	2.84	1.82
11/70-11/73	1.38	1.30
11/73-3/75	2.42	1.54
3/75-1/80	0.70	0.79
1/80-7/80	3.67	3.07
7/80-7/81	1.02	0.76

1. Index computed by dividing U.S. measure of cyclical sensitivity into Indiana value for each contraction and expansionary period. Indices above one signify Indiana employment sensitivity in excess of U.S. employment sensitivity. Index numbers below one indicate U.S. employment sensitivity in excess of Indiana estimate.

The index numbers for the four recessions are listed below.

Recession	*Index Number*
April 1960-February 1961	1.76
December 1969-November 1970	2.84
November 1973-March 1975	2.42
January 1980-July 1980	3.67

For each of the recessions, the index number is greater than 1, indicating a more severe rate of employment decline in Indiana than for the nation. The relationship is particularly clear for the most recent recession. Here, the January 1980 to July 1980 index reveals that Indiana sustained roughly three and one-half times the decline experienced by the nation as a whole.

The expansions experienced since 1960 present a clear contrast with the recssions. Unlike the periods of decline, Indiana and U.S. growth rates were relatively close in each of the four upturns studied. During these periods, Indiana employment increased at an average rate of 16.6%, while U.S. employment gains averaged roughly 16.7%. During the four growth periods between 1960 and 1981, Indiana employment increased by 33.2%, 15.6%, 14.7%, and 2.8%, respectively. National gains stood at 31.6%, 11.3%, 21.2%, and 2.8% during the same periods. Indiana employment increases, when viewed successively, present a more pronounced pattern than do the periods of Indiana employment loss. The four upturns studied showed a fairly steady pattern of decreasing intensity. The second period of Indiana employment growth was less than one-half that of the first upturn. Likewise, the final two periods of growth were even smaller, and the last employment increase was just 2.8%. National employment gains, much like national employment losses, failed to show any clear pattern of increasing or decreasing intensity over time. National employment growth in the second period of increase was only about one-third the level experienced during the earliest such period. A substantial increase appeared during the third growth period, and the final period studied showed only very modest employment gains.

The index computations for the expansions are found below.

Expansion	*Index Number*
February 1961-December 1969	1.05
November 1970-November 1973	1.38
March 1975-January 1980	0.70
July 1980-July 1981	1.02

The index numbers indicate that the rate of employment growth during the March 1975-January 1980 expansion was less in Indiana than for the nation. Only during the November 1970-November 1973 expansion did the rate of employment growth in Indiana significantly exceed that of the nation.

Since recessions and expansions of greater duration are likely to provide greater employment swings, the preceding percent changes do not adequately reflect the rate of change that occurred. The compound annual rate of change for each period, found in Table 4, will thus add to our understanding. Indiana declines expressed as compound annual rates were substantially greater than rates of decline experienced at the national level. Indiana employment declined at an annual rate of 5.5%, 6.1%, 5.6%, and 11.7%, respectively, during the four recessionary periods. Comparable U.S. declines stood at 3.2%, 2.1%, 2.3%, and 3.3%. While Indiana rates of change were greater than U.S. estimates, they also evidenced less stability than did national figures, particularly in the final period. The 11.7% rate of decline that was sustained in the State's last recessionary period stood at nearly twice the next highest estimate.

During three of the four expansionary periods, Indiana compound annual rates of change exceeded those at the U.S. level. Indiana rates stood at 3.3%, 4.9%, 2.9%, and 2.9%, respectively. National employment increased at rates of 3.2%, 3.6%, 4.1%, and 2.8% during the corresponding periods. The period from March 1975 to January 1980 contrasts with other expansions since the U.S. annual rate of change stood somewhat above the Indiana estimate for the first time since 1960. The same relationship is apparent when simple percent changes during this expansion are compared. The U.S. employment gain of 21.1% was significantly higher than the Indiana increase of 14.7%.

The final expansion is an anomaly since it represents the only Indiana expansion that did not provide a return to the pre-recession employment level. During this period, state employment peaked at roughly 1.79 million, falling short of the 1.85 million employment level experienced in the previous upturn. In contrast, all U.S. expansions provided peak employment estimates that exceeded levels attained in previous expansions.

Although one popular notic ı suggests that Indiana's long-run employment growth is comparable to the nation's despite greater losses in recessions, the data suggest that this is not true. The overall net employment change from April 1960 to July 1981 provides insight into long-run growth. Though not strictly an indication of trend, this percent change will indicate the relative performance of Indiana's economy and the national economy during the total period of study. These data reveal that Indiana experienced a 49.2% net employment increase, while the comparable national estimate stood at just over 70%. Indiana is clearly more procyclical (sensitive to employment fluctuations in the direction of the national economy) during downturns than during upturns. During the period of study, Indiana employment gains during upturns closely paralleled those enjoyed at the U.S. level, though much greater employment increases would have been needed to make up losses sustained since 1960. This combination of employment gains and losses led to Indiana's relatively poor employment performance; the State's twenty-year net increase fell more than 20% short of the national economy's twenty-year increase. This observation is of particular significance since it conflicts with one popular notion of Indiana's cyclical sensitivity. Indiana employment gains during these periods of prosperity did not, in fact, offset losses to an extent that would afford Indiana an overall net employment change comparable to that experienced at the national level.

Methodology

To determine the extent to which Indiana's industrial mix has contributed to the severity of employment swings since 1960, we wish to modify the State's industrial composition, as expressed by its employment distribution, to correspond to the nation's industrial mix in each recession and expansion that occurred since 1960. By doing so, we examine Indiana employment growth in the absence of the procyclical influence thought to result from our concentration of firms in cyclically sensitive industries such as steel and auto manufacturing.

The X-11 seasonal adjustment technique was applied to all raw data to eliminate employment fluctuations resulting from production in seasonally sensitive industries. Though no seasonal adjustment method is completely free of error, the X-11 technique is the most widely accepted method for obtaining deseasonalized estimates. To simplify data collection, the tobacco and leather manufacturing industries were deleted, while the remaining Indiana industries form the basis of aggregate employment at both the state and national levels.

Since our study examines the influence of cyclical variation on employment only, employment distribution is used to express industrial mix. We assigned the nation's industrial mix to Indiana employment data by applying U.S. weights (the percentage of total U.S. employment in each industry) to re-allocate initial Indiana employment figures in each period at the industry level. Following this phase, actual Indiana industry growth rates in each period were applied to each new Indiana industry employment estimate to obtain estimates of total Indiana employment at the end of each recessionary and expansionary period that might have occurred if Indiana's economy had possessed the same mix of industries as the nation. We call this the "industry adjusted" or "adjusted" employment level. This technique enabled us to eliminate the differential influence of Indiana's unique industrial mix on employment declines and expansions that occurred in each cycle since 1960.

Estimates of the percentage of total Indiana employment losses that are explained by our adjustment for industrial mix were calculated by first estimating the end-of-period employment level that Indiana might have sustained if the State's employment growth had been exactly the same as the nation's in each recession (U.S. percent declines in each period were applied to actual Indiana employment estimates at the start of each period). The resultant figures will hereafter be referred to as "simulated" employment levels. By subtracting actual end-of-period Indiana employment levels from these estimates in corresponding recessions, we obtain the amount of Indiana employment declines in excess of declines sustained at the national level. We may then express the employment increase that resulted from our adjustment for industrial mix (adjusted Indiana employment minus actual Indiana employment) as a percentage of this figure to estimate the percentage of Indiana employment declines, beyond those experienced at the national level, attributable to industrial mix.

Table 4

Actual and Simulated Total Indiana Employment and Total U.S. Employment, With Compound Annual Rates of Change[1] and With Percentage of Indiana Cyclical Sensitivity Attributable to the Industrial Mix Hypothesis

Period	*Actual Indiana Employment*	*Percent Annual Change*	*Adjusted Indiana Employment*[2]	*Percent Annual Change*	*Actual U.S. Employment*	*Percent Annual Change*	*Indiana Employment Simulated for U.S. Growth Rates*[3]	*Percentage Attributable to Industrial Mix*[4]
4/60-2/61	1,198.388	−5.55	1,219.472	−3.54	43,583	−3.16	1,223.503	83.95
2/61-12/69	1,596.110	3.30	1,598.836	3.32	57,365	3.16	1,557.318	0
12/69-11/70	1,506.465	−6.11	1,538.561	−3.93	56,231	−2.15	1,564.507	55.30
11/70-11/73	1,741.521	4.95	1,727.582	4.67	62,599	3.64	1,676.997	21.60
11/73-3/75	1,612.282	−5.63	1,659.531	−3.56	60,681	−2.31	1,688.230	62.21
3/75-1/80	1,850.149	2.89	1,883.117	3.27	73,516	4.05	1,953.280	0
1/80-7/80	1,738.224	−11.73	1,756.392	−9.88	72,304	−3.27	1,819.622	22.32
7/80-7/81	1,787.823	2.85	1,775.159	2.12	74,325	2.79	1,786.720	0

1. Monthly estimates in thousands at end of contraction and expansionary periods, April 1960-July 1981. Percent changes are from initial to terminal employment levels expressed as a percentage of initial employment level in each period.

2. Indiana employment adjusted for the U.S. industrial mix in each period.

3. Indiana employment in thousands at end of periods calculated by assigning U.S. growth rates in each period to initial Indiana employment level in each period.

4. Percentages represent amount of Indiana cyclical variation in excess of U.S. cyclical variation.

A similar procedure is employed to quantify the influence of industrial mix during upturns. Here, the amount of employment gains in excess of U.S. gains is calculated by subtracting simulated end-of-period Indiana employment estimates from actual employment figures for each expansion. We may then divide the employment change that resulted from our adjustment for industrial mix (actual employment minus adjusted employment) by these estimates to calculate the percentage of Indiana employment gains, in excess of U.S. gains, that are attributable to Indiana's industrial mix. For any given period where Indiana employment patterns did not behave as anticipated by our industrial mix hypothesis, a zero was assigned to the column in Table 4 labeled "Percentage Attributable to Industrial Mix."

Although we were able to estimate Indiana employment that might have existed if our State's employment distribution had been the same as the nation's in each period since 1960, several caveats are in order. Most importantly, it is impossible to estimate precisely the magnitude of state employment changes, given the nation's employment distribution, since a different employment distribution might affect industry growth rates in some fashion that we cannot estimate. Since it is impossible to know how this assigned employment distribution would have affected individual growth rates in each Indiana industry, we assumed that growth rates would not be affected. Although we recognize that the assumption is not entirely realistic, it is the most probable assumption that can be readily implemented in our study.

A second error factor exists because Indiana industrial composition was modified to meet the U.S. distribution only at selected points in each recessionary and expansionary period. The modified employment distribution determined for each employment period was used throughout that period. The ideal approach would recalculate and assign the nation's employment distribution to Indiana in each month studied. However, such a method would entail an inordinate amount of data manipulation.

Finally, we observe that the simulated employment levels computed in this study do not constitute a time series. Each end-of-period industry-adjusted employment level is predicated only upon initial (actual) employment data for the same period. Therefore, each simulated employment period must be viewed in isolation, as if the hypothetical change in industrial mix had taken place at the beginning of that period. In other words, the July 1981 industry adjusted employment estimate is not intended to convey the results of a change in industrial mix that occurred twenty years earlier.

Findings

In each of the contractions since 1960, Indiana's actual end-of-period employment fell below the level simulated for the U.S. employment growth rate during the period. The following table indicates the employment shortfall for each of the contractions.

Contraction	*Actual Indiana End-of-Period Employment—Simulated Employment*
Apr 1960-Feb 1961	−25,115
Dec 1969-Nov 1970	−58,042
Nov 1973-March 1975	−75,948
Jan 1980-July 1980	−81,398

Indiana employment declines would have been dampened in each of the recessionary periods had the State possessed the same industrial mix as the U.S. Table 2 indicates that roughly 21,000 jobs might have been retained had it been possible to modify our State's economy in this manner during the first recession (April 1960-February 1961). Table 3 reveals that assigning the nation's industrial mix to the Indiana economy induces a decline in the index of cyclical sensitivity from 1.76 to 1.12, indicating that the severity of this recession might have been significantly dampened with our hypothetical change in industrial mix. This change is also manifested in the compound annual growth rates calculated to include the influence of the nation's industrial mix component, found in Table 4. A change from the −5.5% annual rate of decline in the actual data to −3.5% is observed when the Indiana economy is more closely tied to the nation's. However, the most striking finding is that 83.9% of Indiana's cyclical swing in excess of the nation's is explained by the industrial mix hypothesis. Table 4 reveals that this is the highest percentage of employment variation attributable to industrial mix evidenced in the four recessions studied.

Table 2 suggests that some 32,000 of the jobs lost during the recessionary period from December 1969 to November 1970 might have been retained had our State's industrial mix been similar to the nation's. This difference is reflected in the index of cyclical sensitivity, which declines from 2.84 to 1.82 when the nation's industrial mix is imposed at the state level. Table 4 also shows that the average annual employment loss during this recession might have been reduced by slightly more than 2% had it been possible to modify the State's industrial mix to correspond to that of the nation. The industrial mix component explains roughly 55.3% of Indiana's employment decline beyond that experienced by the nation as a whole during this recession. This also suggests that almost half of the State's decline beyond the nation's is attributable to greater net rates of decline within industries at the state level than in the same industries at the national level.

Some 47,000 Indiana jobs might have been retained during the November 1973 to March 1975 recession had we had the nation's industrial mix. A shift from 2.42 in the "actual" index of cyclical sensitivity to 1.54 in the "adjusted" index suggests that a substantial decline in Indiana's cyclical sensitivity might have occurred in our hypothetical scenario. Assigning the nation's employment distribution to the Indiana data induces a change in employment losses from −5.63% annually to −3.56% (see Table 4). Table 4 indicates that 62.2% of the State's employment variation in excess of that sustained at the national level can be explained by the industrial mix component. Of the four recessions studied, the period from November 1973 to March 1975 evidenced the

second highest percentage of employment variation explained by the industrial mix hypothesis.

Some 18,000 jobs lost during the final recession studied (January 1980-July 1980) might have been retained if Indiana's industrial mix had been like the nation's. Our hypothetical change in Indiana's industrial composition also produced a moderate decline in the index of cyclical sensitivity. This decreased sensitivity to the national recession is also reflected in a drop in the annual rate of employment loss, from 11.7% to 9.9%. However,. of the four recessions studied, this period appears to provide the least support for our industrial mix hypothesis. Only 22.3% of Indiana's cyclical employment variation resulted from the State's industrial mix. This suggests that greater employment decline within industries at the state level relative to the employment decline in these same industries at the national level was primarily responsible for Indiana's overall employment decline relative to the nation's.

In reviewing the Indiana economy's behavior during the four recessions studied, we note that Indiana employment declines exceeded those experienced by the nation as a whole in each period. Our methodology suggests that employment losses would have been dampened significantly in each period had Indiana's distribution of employment among industries (industrial mix) been equivalent to the nation's. The percentage of Indiana employment shortfalls that can be explained by our industrial mix hypothesis varied substantially, from a maximum of 84% in the April 1960-February 1961 recession to the final period of decline where about 22% of Indiana's employment variation was directly attributable to this factor. The average percentage of employment variation beyond that experienced by the nation explained by the industrial mix component stood at 69.6% for the first two contractions, while the latter two recessions averaged just 42.3%. This suggests that the industrial mix hypothesis has lost some of its explanatory power, while that of the industry growth hypothesis has increased.

Indiana's behavior in the four expansions that have occurred since 1960 is more difficult to explain. In the first two expansions, Indiana's actual end-of-period employment exceeded the levels simulated for U.S. employment growth in each period. In the third expansion, Indiana's actual end-of-period employment was significantly below the simulated level, while in the most recent expansion, actual and simulated end-of-period employment were about equal. The following table illustrates the relationship of actual and simulated end-of-period employment in Indiana for the four expansions.

Expansion	*Actual Indiana End-of-Period Employment—Simulated Employment*
Feb 1961-Dec 1969	+18,792
Nov 1970-Nov 1973	+64,524
March 1975-Jan 1980	−103,131
July 1980-July 1981	+1,103

Since our procyclical hypothesis states that actual Indiana employment swings will be more pronounced than those experienced by the nation in both downturns and upturns, we would expect Indiana's actual end-of-period employment to exceed the simulated end-of-period level based on the overall U.S. growth rate. Furthermore, we would expect Indiana's industry-adjusted end-of-period employment to be lower than the actual end-of-period total. This would indicate that Indiana's industrial mix was favorable during expansions. Our expectations are substantiated for only one of the four expansions studied.

Some 2,726 additional jobs might have been gained in Indiana during the first expansion (February 1961-December 1969) had the State possessed the nation's industrial mix. This observation is contrary to our hypothesis, since we expected that industry adjustment of employment levels would dampen the Indiana expansion. This heightened expansion is reflected in the index of cyclical sensitivity which stood slightly higher when computed with the industry-adjusted Indiana employment level. Here, the index rose from 1.05 to 1.06. The compound annual growth rate increased by a similar amount, moving from 3.3% for actual Indiana data to 3.32% for industry-adjusted employment levels. Consistent with the notion that this expansion fails to support the industrial mix hypothesis, we note that none of Indiana's employment variation during this period was directly attributable to the industrial mix component. Indiana employment during the expansion apparently increased more rapidly than the nation's due to slightly higher rates of growth within individual industries at the state level.

The second expansion (November 1970-November 1973) appears to provide more support for the industrial mix hypothesis, as total Indiana employment decreased when adjusted for the nation's employment distribution. Nearly 14,000 fewer jobs would have been generated with the nation's industrial composition during the period from November 1970 to November 1973. This difference is evidenced in the somewhat lower index of cyclical sensitivity. An "adjusted" index of 1.3 compared with the "actual" index of 1.38 is found in Table 3. The compound annual growth rates found in Table 4 also evidence this difference, dropping from 4.95 to 4.67 when employment levels are adjusted for the nation's industrial mix. Nearly 22% of the excess in Indiana employment gains is explained by industrial mix. This suggests that Indiana's employment during this expansion apparently increased more rapidly than the nation's, due in large part to higher rates of growth within individual industries at the state level.

During the third expansion (March 1975-January 1980), Indiana's actual end-of-period employment was about 103,000 less than a simulated employment level based on the U.S. employment growth rate. Further, the period is an anomaly because Indiana's employment level adjusted for the nation's industrial mix stood nearly 33,000 higher than the actual end-of-period employment. The fact that Indiana's actual end-of-period employment level was below both the simulated level based on U.S. employment growth rates and the employment level based on the

nation's industrial mix is counter to our expectations. This situation suggests that during this expansion, Indiana's employment growth was hampered by both its industrial mix, which was not conducive to growth, and by employment growth rates within industries which were lower at the state than the national level.

The final expansion (July 1980-July 1981) is unique in that it represents the only upturn which did not induce a return to pre-recession employment levels in Indiana. The previous expansion saw State employment rise to 1.85 million but, following the 1980 recession, Indiana employment returned to only 1.79 million. However, despite the modest nature of employment gains experienced during this expansion, roughly 12,600 fewer jobs might have returned had Indiana possessed the nation's industrial mix. This gap represents a difference of one-fourth of one point in the index of cyclical sensitivity and .73% in the compound annual rate of change. The observation that the State's industrial mix adjusted employment would have been below the actual end-of-period level suggests that Indiana's industrial mix was favorable during the last expansion. The fact that Indiana's actual end-of-period employment was about equal to the simulated level based on the overall U.S. growth rate suggests that the favorable industrial mix was offset by unfavorable industry growth rates in Indiana (see Table 4).

In reviewing Indiana's behavior during the four expansions that occurred since 1960, we can state several major findings. During the first upturn, Indiana's employment growth exceeded the nation's. Since none of Indiana's employment variation during this period was directly attributable to the industrial mix component, this growth was probably due to better industry performance in Indiana.

Indiana's employment growth during the second expansion fit our industrial mix hypothesis more closely than it did during other growth periods. Not only did Indiana employment gains exceed national gains by a considerable margin but, in addition, Indiana's industry-adjusted end-of-period employment level dampened Indiana growth, placing it closer to the U.S. growth pattern. Despite a much higher level of employment variation attributable to the industrial mix component, differing state and national industry growth rates were probably the most influential factors in determining Indiana's performance during this period.

Indiana's relatively poor employment growth during the third expansion would have been improved with an industrial composition more nearly tied to the nation's. However, the fact that a majority of the Indiana-U.S. employment growth differential still remained after our adjustment for industrial mix indicates that industry growth rates were again the predominant factor. None of this period's employment variation was directly attributable to the industrial mix hypothesis.

End-of-period estimates for the final expansion reveal that Indiana's employment level exceeded both the employment level adjusted for U.S. industrial composition and the level simulated for the nation's growth rate. However, the small difference of 1,100 noted between actual and simulated employment levels may be considered negligible. This relationship suggests that while Indiana's industrial mix was favorable during this period, much of the State's potential employment increase was offset by less favorable industry growth, resulting in an employment increase roughly equal to national gains.

Among the most striking findings of this report is the substantial difference in the explanatory power of the industrial mix hypothesis observed when recessions and expansions are compared. An average of 55.9% of Indiana's cyclical employment variation, apart from that experienced by the nation as a whole, was attributable to our industrial mix hypothesis during the four recessions studied. In contrast, the industrial mix explanation was applicable in only one of the expansions, and in the February 1961-December 1969 and March 1975-January 1980 periods the State's industrial mix hurt, rather than helped, the State.

Observations and Interpretations

By applying U.S. growth rates in each period to Indiana data, we were able to simulate the job gains or losses that would have occurred at the state level given the nation's rate of change in employment. This calculation affords comparison of Indiana and U.S. performance in terms of job gains and losses. While the preceding narrative has isolated each contraction and expansion as a separate employment period, it will be useful to discuss the following data in terms of four major employment cycles, each consisting of one contraction and one expansion. Table 5 lists the difference observed between actual Indiana employment and Indiana employment simulated for U.S. growth rates in each period. Compound annual gains or losses in employment experienced in the contraction and expansion of each employment cycle are also provided.

Since our industrial mix hypothesis anticipated greater employment losses at the state level during recessions (resulting in a negative actual minus simulated figure), and since these losses were largely offset during expansionary phases (illustrated by a positive actual minus simulated employment figure), Indiana's overall employment growth pattern during the first two employment cycles seems acceptable. However, the two full employment cycles that occurred since 1973 present a sharp contrast. The cycle from November 1973-January 1980 is the only one in which simulated employment exceeded actual employment in Indiana during both the recessionary and expansionary phases. Not only was this situation unique in itself but, additionally, the March 1975-January 1980 expansion provided the largest gap between actual and simulated employment of all employment periods studied. Consistent with this observation, the same period yielded one of the lowest compound annual growth rates among expansions at the Indiana level. The expansionary phase of this cycle is also unique in that both an unfavorable industrial mix and poor industry growth rates relative to national growth contributed to Indiana's

poor performance. Combined recessionary and expansionary actual minus simulated shortfalls during this cycle were larger than those sustained in any other cycle, as actual Indiana employment lagged behind simulated Indiana employment by 179,000 jobs.

The final employment cycle (January 1980-July 1981) evidenced a severe, though markedly different, pattern of gains and losses. Again, a large gap between actual and simulated employment estimates is apparent during the recessionary phase. While the expansionary actual minus simulated gap once again favored the actual Indiana employment estimate, the difference was too small to offset any substantial portion of the recessionary shortfall. Further, this expansionary phase represents the only period of employment gain that failed to see Indiana employment return to pre-recession levels. Accordingly, Indiana's actual employment fell short of its simulated employment level for the full cycle by roughly 80,000 jobs, the second highest estimate observed during the period of study.

Viewing the four employment cycles as a whole, two additional observations are noteworthy. A cursory review of the actual minus simulated employment gap in the preceding table reveals a steady pattern of increasing shortfalls. Indiana employment declines during contractions exceeded national employment losses by increasing amounts throughout the period of study. However, Indiana employment gains failed to follow a similar pattern during expansionary periods. For the given period of study, we may conclude that Indiana became more procyclical during recessions, but failed to offset increasing losses by becoming more procyclical during expansions.

For the total period of study, we note that an average of just 30.7% of Indiana employment swings beyond the limits of U.S. employment swings resulted from Indiana's unique industrial mix. This observation leads us to conclude that at least one additional factor, differential intra-industry growth rates found at the state and national levels, played a significant role during the period of study. During the 1970s, several important sectors of the economy, including nondurables manufacturing, retail trade, finance, insurance, real estate, government and agriculture grew less rapidly in Indiana than at the national level. As previously noted in this report, the industry growth rate differential was clearly more influential during expansions than recessions.

The most striking feature of the employment patterns studied is found in the November 1973-January 1980 employment cycle. Both the character and severity of employment shortfalls experienced during this period suggest the intervention of some outside factor that is beyond the scope of this report. However, the following observations may suggest a plausible explanation for the employment patterns noted above.

The 1973 formation of the Organization of Petroleum Exporting Countries (OPEC) indirectly led to a quadrupling of world oil prices. Dramatic energy price increases were not confined to petroleum products alone, but instead extended to energy costs in general, as well as to other inputs to the manufacturing production process. Devaluation of the dollar during the period from 1971 to 1973 compounded this problem by further increasing the cost of imported materials needed for American manufacturing operations. These and other cost increasing factors served as constraints to investment and employment increases, particularly in energy intensive industries. Since energy is a particularly important manufacturing cost to many of the major employers found in Indiana, including the steel, glass, iron and steel foundry, nonferrous rolling and drawing, grain mill products and drug industries, the State may have been disproportionately affected by these events. Although it is difficult to estimate the influence of such factors, they no doubt augmented the employment losses sustained by Indiana and other states with a substantial proportion of energy intensive industries during this period.

The findings of this report suggest that the State of Indiana has experienced unique obstacles to economic growth in both recessions and expansions. Although most of the underlying causes cited are not subject to control by state government, their existence underscores the need for maintaining an aggressive approach to economic development. It is entirely possible that Indiana's current industrial development program, coupled with newly created economic development incentives, may provide the most realistic method available for improving the long-run growth of Indiana employment levels. □

Table 5

Actual Minus Simulated Indiana Employment with Compound Annual Rates of Change

Employment Period		*Actual–Simulated Indiana Employment*	*Compound Annual Rate of Change*	
			Indiana	*U.S.*
Contraction	April 1960-February 1961	−25,115	−5.5	−3.2
Expansion	February 1961-December 1969	+18,792	3.3	3.2
Contraction	December 1969-November 1970	−58,042	−6.1	−2.1
Expansion	November 1970-November 1973	+64,524	4.9	3.6
Contraction	November 1973-March 1975	−75,948	−5.6	−2.3
Expansion	March 1975-January 1980	−103,131	2.9	4.1
Contraction	January 1980-July 1980	−81,398	−11.7	−3.3
Expansion	July 1980-July 1981	+1,103	2.9	2.8

Input-Output Analysis for the Indiana Economy

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Several factors contribute to an increased need for state-level economic analysis in Indiana. First among these is the fact that both the national and the state economies are in a period of transition. In particular, Indiana has a disproportionate share of the traditional, heavy industries, many of which are facing a decline nationwide. In addition, recent attempts to decentralize decision making under the "New Federalism" have encouraged individual states to take a larger role in managing their own economic destinies. The State of Indiana has responded with the most substantial economic development program ever enacted, conceived by the Indiana Department of Commerce. New employment and greater income within the state are primary objectives for the economic development plan.

One means of increasing employment and income is to increase the share of processing which is done within the state. This amounts to enlarging the value added to products prior to their export. For example, we have estimated that in 1977 Indiana shipped $3.8 billion worth of raw steel and blast furnace products, or 61% of production, out of the state—while importing from other states a net $40 million worth of steel pipe and tubes. Indiana also produces a surplus of grains yet is a net importer of prepared feeds and meat animals as well as packed meat products. Increased secondary processing of these and other products in Indiana would generate both direct and indirect business activity, jobs, and income. In this article, we present estimates of these statewide benefits. It is hoped that this will aid policymakers in targeting future feasibility studies and potential economic development initiatives.

The Input-Output Table

The input-output (I-O) table provides us with a snapshot of the state's economy at a given point in time. It accounts for all purchases and sales of goods and services among productive sectors, households, and government. Table 1 provides an outline of a highly aggregated input-output table. Entries are made initially in dollar terms. Row labels refer to sectors of origin and primary factor payments (value-added). Thus, the cross-hatched row identifies where the state's agricultural output goes. These entries sum to total gross agricultural output. Column labels identify purchasing sectors and final demand. "Final Demand" comprises household and government purchases, as well as investment and net exports. The cross-hatched column represents purchases by the agricultural sector. These are inputs to the production process and include purchases from other sectors as well as payments to primary factors (labor, capital, and indirect business taxes) which, when combined, amount to value-added. Both columns and rows in the table must sum to gross output, thus enforcing consistency between sources and uses of each sector's production.

But where does all this information come from? The U.S. Bureau of Commerce conducts an exhaustive survey every five years in order to generate a new I-O table for the U.S. economy. Ideally, measurement of interindustry relationships at the state level should be based on the same type of primary data. Unfortunately, the expense of conducting and processing such a state survey, on a regular basis, would be

Comments on Input-Output Analysis

Input-output analysis has been widely used in studies of state and regional economies, but the reliability of the variables used in these models has been subject to question. Some critics believe the numbers are not at all reliable and therefore have no confidence in the resulting analyses. The multipliers in the accompanying study are, in numerous cases, considerably larger than those reported in similar studies using different methods. In part, these large multipliers may result from the use of average, rather than marginal, relationships and the use of data for only one year.

Nevertheless, input-output studies are useful, as the authors state, because they show specifically the interindustry relations of an economy. One should keep in mind, however, that the results may be subject to large errors and should be used cautiously. Policy makers should consider these results as possible, but not certain, outcomes.

Whether it is feasible for Indiana to promote additional processing of raw materials depends upon the state's competitive position relative to other states that engage in this processing. The input-output model provides no information in this area, the key question for policy makers. As the authors point out, the costs and benefits associated with the promotion of any activity must be carefully assessed by the policy makers so that they do not "give away the store." □

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prohibitive. Thus, virtually all regional I-O tables are based on non-survey techniques. These combine the state-level data which is available with detailed information from the national I-O table to create a snapshot of the regional economy at a given point in time.

The Steel Industry

The 1977 data presented in Table 2A demonstrate the importance of the steel industry to the Indiana economy. Indiana's raw steel production ($6.2 billion) represented about 16% of national output in that year. We estimate that 61% of that production was shipped to other states for further processing.[1] The remainder, approximately 6% of the nation's steel output, was utilized within the state. Much of the steel processed in Indiana represented inputs into the industries listed in Table 2A. Fabricated metal, metal stamping, cold finished steel (11% of national output), and wire industries added significant value

1. The surplus and deficit figures in Tables 2A and 2B do not include net trade with the rest of the world. This could not be estimated (see Hertel and McKinzie: 6). In most sectors, net trade with the rest of the U.S. dominates net foreign trade, in which case the numbers in Tables 2A and 2B are indicative of the overall trade situation for Indiana.

Table 1

Input-Output Table

		PURCHASERS									FINAL DEMAND (GNP)				GROSS OUTPUT (X)
		Agriculture	Mining	Construction	Manufacturing	Transportation	Trade	Finance	Services	Other	Personal consumption expenditures	Gross private domestic investment	Net exports	Government purchases	
PRODUCERS	Agriculture														
	Mining														
	Construction														
	Manufacturing														
	Transportation						(A)						(B)		
	Trade														
	Finance														
	Services														
	Other														
VALUE ADDED (Charges against GNP)	Compensation of employees														
	Profit-type income*, net interest & capital consumption allowances						(C)								
	Indirect business taxes														
GROSS INPUT (X)															

*Consists of proprietors' income, rental income of persons, corporate profits, and business transfer payments, less subsidies, etc.

U.S. Department of Commerce, Bureau of Economic Analysis

to raw steel before shipping much of their production out of the state. Indiana was estimated to be a net importer of several major secondary steel products, including steel pipe and tube, iron and steel forgings, and railroad equipment. The steel-using industries shown in Table 2A provided about 4.4% of the state's jobs, and raw steel production provided another 3%. Wage levels in these industries tended to be significantly above the state average of $13,500 per year.

Agriculture

Data in Table 2B indicate that, in 1977, Indiana produced about 4% of the nation's grains and 7% of oil-bearing crops (primarily soybeans). Significant quantities of each of these primary products are processed within the state.[2] Eighty-nine percent of blended and prepared flour production was shipped out of the state. Those shipments exceeded domestic usage by eight times. Indiana production accounted

2. In the case of grains and soybeans, foreign trade is extremely important. Exports to other countries from Indiana were estimated to be $150 million and $114 million, respectively, in 1977. These shipments are not included in the surplus total in Table 2B (see also footnote 1).

Table 2A

Data on Selected Sectors of the Indiana Economy (1977)

	Gross Output			Indiana Surplus			Employment				
			IN		Percent of:				Wages	Output	Sales
Industry	U.S.	IN	U.S.	Total	Use	Production	Jobs	Wages	Job	Job	Multipliers
	(Million $)		Percent	(1000 $)	Percent	Percent	Number	(1000 $)	$	$	
Blast Furnace & Steel	39529	6203	16	3808213	161	61	56690	1328625	23437	109420	1.61
Other Furniture and Fixtures	5632	181	3	5292	3	3	5060	60889	12031	35847	1.61
Steel Wire and Related Products	2227	100	4	11186	13	11	906	15636	17255	110351	1.74
Cold Finished Steel	2723	311	11	150354	95	48	664	15288	23013	467861	2.01
Steel Pipe and Tube	3010	133	4	−40168	−23	−30	272	4501	16518	488807	1.89
Iron and Steel Forgings	2618	90	3	−20735	−17	−21	1421	26461	18627	63635	1.82
Metal Containers	8823	442	5	189539	76	43	1917	45886	23931	230416	1.89
Fabric Metal	22991	843	4	127644	19	15	16397	2468836	15056	51387	1.80
Screw Machine Products	5054	168	3	−82722	−33	−49	3521	56983	16183	47798	1.67
Metal Stamping	14731	1036	7	357689	55	34	19093	438909	22988	54288	1.72
Cutlery, Hardware, General	8177	271	3	−35341	−120	−13	5277	81627	15469	51301	1.56
Other Fabricated Metal	17104	811	5	161361	26	20	12752	195176	15305	63589	1.64
Farm Machinery	11579	380	3	17076	5	4	4971	108577	21841	76481	1.78
Material Handling Machinery	4766	140	3	−4226	−3	−3	2977	39142	13059	46644	1.72

Source: McKinzie and Hertel (1984).

Table 2B

Data on Selected Sectors of the Indiana Economy (1977)

	Gross Output			Indiana Surplus			Employment				
			IN		Percent of:				Wages	Output	Sales
Industry	U.S.	IN	U.S.	Total	Use	Production	Jobs	Wages	Job	Job	Multiplier
	(Million $)		Percent	$1000	Percent	Percent	Number	(1000 $)	$	$	
Grains	28635	1135	4	231796	31	20	11332	4635	4080	100123	1.51
Flour and Other Grains	3595	101	3	4110	4	4	1004	22625	22526	100856	1.98
Blended and Prepared Flour	1089	250	23	222810	818	89	1135	19360	17055	220529	1.90
Pet Food	3146	14		−69902	−82	−510	134	3888	29076	102132	2.09
Wet Corn Milling	2018	302	15	234177	388	78	1423	51570	36233	212183	1.91
Oil-Bearing Crops	10106	719	7	210406	53	29	8005	32660	4080	89826	1.39
Prepared Feeds	10203	233	2	−18666	−6	−8	2204	49356	22394	105672	2.51
Fats and Oils	13408	819	6	384363	102	47	2668	73271	27464	307058	2.22
Miscellaneous Chemicals	7996	119	1	−106281	−48	−89	923	7217	7822	129294	1.57
Paints	6251	105	2	−90330	−45	−84	1326	25823	19480	79436	1.62

Source: McKinzie and Hertel (1984).

for 23% of the nation's output. The Indiana wet corn milling industry processed 15% of the nation's wet milled corn. It also has the highest imputed average wage (see Wages/Job column in Table 2B) of those sectors studied.

Soybean processing (fats and oils) in the state accounted for about 6% of national oil meal processing. Slightly more than half of that output was shipped out of the state without further processing. The outputs from soybean processing which are not directly exported from the state are widely dispersed throughout the economy, with relatively small amounts going to a large number of industries. While the prepared feed industry requires sizable inputs from the grains sector, it is listed under oil-bearing crops since significant quantities of soybeans are utilized by the feed industry. Two other manufacturing industries which utilize significant quantities of input from the fats and oils sector are miscellaneous chemicals and paints. Indiana was a significant importer of both of these products.

Sales Multipliers

When output in a given sector increases, there are both direct and indirect effects on the remainder of the state's economy. If sales to final demand for one product increase by $1, then gross output of that sector must increase by $1. This is the direct effect. But indirect effects also ripple through the remainder of the economy. These arise because the inputs necessary to produce the finished product place increased demands on the firm's suppliers. For example, Table 3 provides 1977 estimates of some of the direct input requirements for selected primary metals and metal fabrication sectors. Blast furnaces show large requirements for coal and other energy inputs, and the output from this sector represents a large portion of the inputs into the other three industries. Machinery and maintenance and repair inputs are also important, as are the services of transportation and wholesale trade sectors. The four purchasing sectors in Table 3 are clearly highly interdependent. For example, a decline in the demand for cold finished steel will cause a substantial decline in basic steel requirements which, in turn, will affect numerous other sectors. These effects are captured in the sectoral sales multipliers, which measure the direct and indirect change in economy-wide gross output when final demand for a given product changes by $1.

Sales multipliers for selected Indiana steel and agricultural sectors are provided in the last column of Tables 2A and 2B. The larger sales multipliers indicate greater indirect effects. Processed products tend to have larger multipliers due to the fact that they require raw materials which, in turn, require other inputs to be produced. This chain, extending back from the final product through the processing activities to the raw materials, and beyond, may be termed the "backward linkage" associated with a given product. Of course, these "backward linkages" tend to be more extensive as the degree of processing increases. Furthermore, if the raw materials are imported, then the backward linkages do not stimulate the Indiana economy. As a result, we expect that the import-intensive sectors

Table 3

Production Requirements in Selected Metals Sectors: 1977 ($1,000)

	Purchasing Sector			
Selected Indiana Producing Sectors	*Blast Furnace Basic Steel*	*Iron and Steel Foundries*	*Cold Finished Steel Shaping*	*Metal Shapings*
Coal Mining	155,712	45	463	277
Maintenance and Repair	39,237	616	2,596	1,735
Industrial Chemicals	31,518	6,191	195	1,070
Petroleum Refining	79,210	3,977	3,442	4,830
Lime, Gypsum	25,037	0	31	8
Miscellaneous Stone and Clay	26,198	2,977	5,352	2,312
Blast Furnace, Steel	699,959	105,387	28,343	216,930
Cold Finished Steel Shaping	49,436	8,536	1,850	14,543
Steel Pipe and Tubes	38,041	5,817	1,505	12,004
Iron and Steel Foundries	75,834	2,226	4,512	2,115
Metal Heat Treatment	11,967	765	4,761	1,958
Other Primary Copper Products	13,144	700	224	12,349
Primary Aluminum and Products	12,162	193	1,489	27,345
Other Primary Non-ferrous	80,880	2,250	2,921	5,306
Screw Machine Products	21,558	1,908	31	6,389
Metal Stampings	13,400	174	258	24,556
Other Fabricated Metal	59,283	8,440	392	9,475
Metalworking Machinery	25,415	1,192	3,180	5,884
General Industrial Machinery	74,375	8,190	16,770	892
Machine Shops	8,782	3,203	9,132	7,972
Electrical Industrial Apparatus	28,241	643	10,134	1,748
Railroad Transportation	96,793	1,530	2,904	2,468
Truck Transportation	21,885	823	1,598	1,756
Electric Utilities	95,472	1,923	10,982	6,076
Gas Utilities	73,146	1,356	3,785	1,635
Wholesale Trade	247,554	4,954	30,634	29,035
Miscellaneous Business Services	24,106	2,821	2,611	2,942
Scrap, Used Goods	75,675	0	12,550	709
Total Intermediate Inputs	2,487,441	196,886	191,396	465 731
Indiana Imports	1,183,713	49,511	37,862	53,035
Value Added	2,531,846	293,303	81,542	517,734
Gross Output	6,203,000	539,700	310,800	1,036,500

Source: Hertel and McKinzie (1983).

have lower sales multipliers than those sectors which utilize local raw materials.

As noted above, the sectors in Tables 2A and 2B have been grouped according to primary products—raw steel, grains, and oil-bearing crops—followed by several processed products requiring significant quantities of the primary product as inputs. Multipliers for all but a very few of the processed products are higher than those for the associated raw products. Multipliers for processed agricultural products tend to be higher than those for steel, due to the fact that the majority of raw agricultural inputs are produced within the state. The steel industry, however, requires a significant amount of imported fuel and iron ore.

Employment Multipliers

Although it is useful to measure the sales impact of an exogenous change in final demand, it is the resulting change in employment and income which is of primary interest to policy makers. In order to translate increases in gross output into a change in employment, the sales multipliers are weighted by the employment generated per dollar of gross output. These new multipliers measure the increase in economy-wide employment resulting from the creation of an additional job in a given sector. They are provided, for selected sectors, in Table 4. Where possible, primary products are grouped with their respective processing sectors. Once again, the latter tend to have larger employment multipliers due to the increased effort embodied in producing a finished product.

The largest employment multiplier for all sectors is found in cold finished steel (7.26). A drop in demand for this sector's product that results in the loss of 100 employees can be expected to eventually lead to the loss of 626 additional jobs elsewhere in the economy. Some of those jobs will be in basic steel (blast furnaces) which itself has an employment multiplier of 2.01. Table 5 systematically decomposes the employment multiplier associated with cold finished steel. It can be seen that the backward linkage to basic steel production is indeed very large. The loss of one job in cold finished steel is estimated to result in the eventual loss of 1.8 jobs in basic steel.

The other entries in Table 5 emphasize once again the close links among primary metals and fabrication activities, machinery, equipment, transportation, and service sectors. The seventeen sectors in this table encompass 75% of the direct and indirect job losses when the demand for Indiana's cold finished steel drops. The remaining effects are spread fairly uniformly over a large number of sectors.

Refer again to Table 4 and note that cold finished steel shaping and steel pipe and tubes are rather exceptional sectors as measured by their employment multipliers. The next largest numbers appear in the agricultural processing area. Indeed, these sectors make up over half (12 of 21) of the top 10% of Indiana industries, ranked by employment multipliers. This is a reflection of the large sales multipliers mentioned above, as well as the relatively low employment/output ratio in commercial agriculture.

Table 4

Employment Multipliers for Selected Sectors in Indiana

Sector	*Multipliers*
Primary Metals and Fabrication	
Cold Finished Steel Shaping	7.26
Steel Pipe and Tubes	6.78
Primary Aluminum and Products	2.49
Blast Furnace	2.01
Metal Stamping	1.52
Iron and Steel Foundries	1.37
Crops and Processing	
Fats and Oils	5.19
Blended Flour	3.45
Wet Corn Mill	3.23
Prepared Feed	2.58
Flour	2.19
Grains	1.58
Soybeans	1.42
Livestock and Products	
Meat Packing	3.90
Sausages and Other	3.63
Meat Animals	2.83
Poultry Dressing	2.51
Poultry and Eggs	2.14
Dairy Products	
Cheese	3.37
Milk	3.01
Condensed and Evaporated Milk	3.01
Dairy Farms	2.20
Other Manufacturing	
Motor Vehicles	2.30
Agricultural Chemicals	2.09
Farm Machinery	1.99
Drugs	1.93
Aircraft	1.82
Canned Vegetables	1.71
Industrial Chemicals	1.70
Energy	
Petroleum Refining	2.37
Oil and Gas	1.60
Coal	1.49

Source: Hertel and McKinzie (1983).

Effects of Increasing Value-Added

The difference between the economic multipliers for raw vs. processed products underscores the importance of analyzing the potential for increasing the processing

Table 5

Decomposing the Employment Multiplier for Cold Finished Steel Shaping

Sector in Which Employment Declines	*Number of Jobs Lost*
Maintenance and Repair	0.107
Industrial Chemicals	0.108
Miscellaneous Stone and Clay	0.112
Blast Furnace, Steel	1.798
Cold Finished Steel Shaping	1.033
Iron and Steel Foundries	0.183
Other Primary Non-ferrous	0.247
Other Fabricated Metal	0.265
Metalworking Machinery	0.107
General Industrial Machinery	0.296
Machine Shops	0.116
Electrical Transportation Equipment	0.114
Electrical Industrial Apparatus	0.111
Railload Transportation	0.237
Truck Transportation	0.223
Wholesale Trade	0.128
Miscellaneous Business Services	0.267
Subtotal	5.452
Other Sectors	1.807
Total Employment Multiplier	7.259

Source: Hertel and McKinzie (1983).

of raw products prior to their export from Indiana. Clearly there will be benefits, in the form of additional jobs, when the value-added embodied in exports is increased. However, to the extent that subsidies and concessions are used to attract additional manufacturing activity, it is important that policy makers have a fairly accurate picture of the magnitude of these benefits. Without this information they run the risk of "giving away the store." That is, in their enthusiasm for attracting new economic activity, they may give industries concessions whose costs exceed the benefits accruing to the state's economy. Since the methods used in this article tend to provide an upper bound on the potential gains attributable to new processing activity, concessions exceeding our estimated benefits must be seriously questioned.

Steel. Table 6 presents information on the effect of increasing the processing of raw steel in Indiana. The (direct and indirect) intermediate input coefficients in column 1 tell us, for example, that a total of $0.42 worth of raw steel is required from the blast furnace for the production of $1.00 of cold finished steel. When we take into account the fact that raw steel is required as an input into its own production, we find that $1.00 of raw steel is sufficient to produce $2.73 of cold finished steel. This is the "export expansion multiplier" given in column 2 of Table 6.

Next, we assume that other intermediate inputs, as well as the capital and labor necessary to process the raw steel, are forthcoming in perfectly elastic supply. (In other words, our estimates assume that if the demand for Indiana value-added increases, we can respond by increasing production, at relatively constant costs.) The resulting increases in gross state output, employment, and income due to the processing of an additional $1 million of raw steel are provided in columns 3, 4, and 5 of Table 6. These indicate that if, in place of the raw steel, $2.726 million of cold finished steel were exported, gross state output would increase by $3.867 million and 24 more jobs, paying $415,000, would be created. Of course, if our basic assumption about factor supplies

Table 6

Implications of Additional Processing of Raw Steel Within Indiana

			Effect of Foregoing $1 Million Raw Product Exports		
	1	*2*	*3*	*4*	*5*
Processed Product	*Intermediate Input Coefficient*[1]	*Export Expansion Multiplier*	*Economic Activity Multiplier*	*No. Jobs /Million $*	*Wage Income /$1000*
Cold Finished Steel	.420	2.726	3.867	24	415
Iron and Steel Forgings	.366	3.133	4.084	64	1143
Steel Pipe and Tube	.350	3.185	4.392	27	406
Metal Containers	.311	3.681	5.335	40	786
Steel Wire and Related Products	.270	4.243	5.759	64	1048
Metal Stampings	.263	4.351	5.889	104	2218
Fabricated Metal	.241	4.762	6.972	127	1939
Screw Machining Products	.191	6.015	8.456	167	2637
Material Handling Machines	.127	9.003	13.864	283	3903
Farm Machinery	.111	10.311	16.786	249	4916
Other Fabricated Metal	.108	10.635	15.812	253	3860
Cutlery Hardware General	.108	10.647	15.012	289	4368
Other Furniture and Fixtures	.103	11.163	16.396	409	5115

1. The intermediate input coefficient provides the direct and indirect raw steel requirements necessary to supply $1 of a given product to the processing sectors.

Source: McKinzie and Hertel (1984).

Table 7

Implications of Additional Processing of Grains and Soybeans Within Indiana

			Effect of Foregoing $1 Million Raw Product Exports		
	1	*2*	*3*	*4*	*5*
Processed Product	*Intermediate Input Coefficient*	*Export Expansion Multiplier*	*Economic Activity Multiplier*	*No. Jobs /Million $*	*Wage Income /$1000*
Grains					
Flour and Other Grains	.536	1.950	2.350	27	544
Wet Corn Milling	.436	2.396	3.057	21	564
Meat Animal	.420	2.490	4.612	45	389
Meat Packing	.306	3.410	8.579	75	779
Dairy Farms	.298	3.510	5.120	92	730
Poultry and Egg Farms	.256	4.086	8.970	128	1281
Prepared Feed	.222	4.711	10.317	99	1905
Poultry Dressing	.168	6.204	16.108	247	2567
Blended Prepared Flour	.164	6.359	10.555	85	1359
Sausages and Other	.143	7.288	17.921	155	2019
Poultry and Egg Processing	.124	8.405	19.973	328	2899
Fluid Milk	.113	9.220	17.198	203	2474
Soybeans					
Fats and Oils	.498	2.096	3.275	20	374
Prepared Feeds	.136	7.644	17.802	171	3177

Source: McKinzie and Hertel (1984).

is not satisfied, and input prices rise, then the increase in output will be dampened. In this sense these numbers represent upper bounds on the economy-wide benefits of increasing value-added.

The sheer size of Indiana's raw steel surplus suggests that substantial opportunities for additional processing are present. The estimated employment effects presented in Table 4 provide state policymakers with information to evaluate the economic effects of alternative development strategies and to compare different alternatives. In 1977, Indiana produced 16% of the nation's raw steel but only 11% of cold finished steel. One might ask what would happen if Indiana were to produce an equivalent share of cold finished steel (from Table 2A, 16% of $2.723 billion = $435 million). Cold finished steel processing in the state would need to be increased by about $125 million. The state's raw steel surplus would decrease by $52 million (about 1.4%). Economic activity in the state would increase by $177 million. State employment would increase by 1,125 jobs, and wage compensation in the state would increase by $19 million.

Other processed products embodying significant amounts of raw steel are listed in Table 6 as well. They are ordered according to the amount of raw steel required per dollar of output (direct and indirect intermediate input coefficient). It is hardly surprising that the economic activity multipliers increase as the intermediate input coefficient drops. When this coefficient is small, it means that many other goods and services must be combined with the raw steel before the processed product is complete. Since we are assuming these other goods are in perfectly elastic supply, the estimates become less and less plausible as we move down the list.

Agricultural Crops. Substantial amounts of grain are processed directly in Indiana. Indiana's share of national wet corn milling was 15% and 23% for blended and prepared flour (see Table 2B). Turning to Table 7, we see that if the state were somehow to capture an additional 5% of the nation's wet corn milling, say $100 million, foregoing shipments out of the state of $44 million worth of unprocessed corn, economic activity within the state would increase by $305 million, 2,100 new jobs would be created, and wage income within the state would increase by $564,000.

Significant amounts of Indiana grain are also fed to livestock. Hence, livestock production and processing activities can also be considered as grain "processing" activities. In fact, the largest possible gains from utilization of surplus grain in the state derive from feeding the grain to livestock and subsequently processing the meat. If the state were to increase production of dressed poultry by $7.7 million (roughly 10% of the current deficit) by foregoing $1.3 million in unprocessed grain shipments, economic activity within the state would increase by $120 million, 1,900 new jobs would be created, and wage income in Indiana would increase by $20 million.

Nearly 30% of Indiana soybeans are exported to other states in unprocessed form ($210 million surplus). About 57% of the state's soybean production ($408 million) is required by the state's fats and oils industry. Expanding soybean processing to utilize all of the state's $210 million soybean surplus would mean increasing the level of fats and oils output by $422 million, creating 4,200 new jobs in the state, and generating $78 million additional wage income (see Table 7).

Input output analysis is a useful tool for measuring the likely effects of some of the changes which the Indiana economy is currently experiencing. Its particular strength rests in its ability to take into account the interdependent nature of production processes. Thus, we have been able to generate economic multipliers which capture both direct and indirect effects of an exogenous change in a given sector's output. We have also been able to examine the likely benefits associated with increasing the value-added embodied in Indiana exports. We hope that the availability of this type of information will assist policy makers in designing future economic development strategies. □

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